ER40

ELECTRICAL WORKERS
REGISTRATION BOARD
Safety • Competency

Candidate Code No.	
For Board Use Only	
Result	Result
Date	Date
Int	Int

ELECTRICIAN'S REGULATIONS EXAMINATION

27 November 2010

QUESTION AND ANSWER BOOKLET

Time Allowed: Three hours

INSTRUCTIONS – READ CAREFULLY

You have 10 minutes to read this paper but do not start writing until you are told to do so by the supervisor.

Write your Candidate Code Number in the box provided above. Your name must NOT appear anywhere in this paper.

Answer all questions.

The pass mark for this examination is 60 marks.

Use a pen for written answers. **Do not** use pencils or red pens.

Drawing instruments and pencils may be used when diagrams are required. Marks are allocated on the basis of correctness.

Do not use correcting fluid or correcting tape.

Non-programmable calculators may be used.

It is recommended that the reference source for your answers be included in the space provided if a question can be answered from the Act, Regulations, Standard or Code of Practice. However, just stating a reference only will earn no marks.

For calculation questions all workings, including formulae, must be shown to gain full marks.

Warning – You could get 0 marks for any question, or part of a question, if you show anything hazardous or dangerous in your answer.

You may need to use the following documents in this examination:

- The Electricity Act 1992 reprint dated 2008 **and** The Electricity Amendment Act 2006 **or** The Electricity Act 1992 reprint dated 1 April 2010
- Electricity (Safety) Regulations 2010
- AS/NZS 3000:2007 and Amendment No 1; AS/NZS 3001:2008 and Amendment A; AS/NZS 3004.1:2008; AS/NZS 3760:2003 and Amendment No 1 or AS/NZS 3760:2010
- NZECP 34

PLEASE HAND THIS PAPER TO THE SUPERVISOR BEFORE LEAVING THE ROOM

(turn over)

Question 1

(a) A registered electrician is carrying out prescribed electrical work on an electrical installation. The electrician discovers that part of an installation presents an immediate danger to life.

Refer to the Electricity (Safety) Regulations and state who the electrician must advise of the danger?

(2 marks)

Ref: ....

(b) Refer to the Electricity (Safety) Regulations and state **FOUR** types of prescribed electrical work that require inspection by a registered electrical inspector.

(2 marks)

(1)

(2)

(3)

(4)

Ref: ....

(turn over)

Question 1 continued

(c) A main switchboard is installed in a dedicated cupboard and is enclosed by a single lockable door. The switchboard cupboard is located in a passage-way.

Refer to AS/NZS 3000 and state the requirements relating to access to the switchboard.

(2 marks)

Ref: ……………………………………

(d) A three phase-induction motor is controlled by a direct-on-line starter. A four core flexible cord will be used to connect the motor to the starter.

Refer to AS/NZS 3000 state **ONE** set of **recommended colours** for the active (phase) conductors of the flexible cord.

(2 marks)

Ref: ……………………………………

(turn over)

Question 1 continued

(e) A four-core neutral screened cable with **hard-drawn copper conductors** is being installed overhead between two buildings in an industrial complex.

Refer to AS/NZS 3000 and state:

(i) The minimum size and type of neutral screened cable permitted to be installed as an aerial conductor.

(1 mark)

____

Ref: ……………………………………

(ii) The minimum size of neutral screened cable permitted to be installed if the aerial span is 55 metres.

(1 mark)

____

Ref: ……………………………………

(f) Refer to AS/NZS 3000 and state the **TWO** requirements relating to the installation of an overtemperature cut-out for an **unvented water heater**:

(2 marks)

(1) ____

____

____

(2) ____

____

____

Ref: ……………………………………

(turn over)

Question 1 continued

(g) A motor can cause danger to persons if it restarts unexpectedly.

Refer to AS/NZS 3000 and state the requirement relating to a motor that may cause danger if it restarts unexpectedly.

(2 marks)

Ref: ……………………………………

(h) Refer to AS/NZS 3000 and state **FOUR** types of piped non-electrical services that cannot be used as an earthing medium.

(2 marks)

(1) __________

(2) __________

(3) __________

(4) __________

Ref: ……………………………………

(turn over)

Question 1 continued

(i) Fittings used in damp locations have a classification system to indicate the degree of protection against touching of live parts and ingress of water.

If a fitting is marked IP 24:

(i) What degree of protection is provided by the number 2?

(1 mark)

Ref: ....

(ii) What degree of protection is provided by the number 4?

(1 mark)

Ref: ....

(j) The earth fault loop impedance of a final subcircuit must be low enough to ensure that the protective device will operate within 0.4 seconds under fault conditions. The impedance of a final subcircuit depends, in part, on its length.

Refer to AS/NZS 3000 and state the maximum length of a 2.5 mm^2 TPS final subcircuit when it is protected by:

(i) A 16A, Type C MCB.

(1 mark)

Ref: ....

(ii) A 16A “gG” type HRC fuse.

(1 mark)

Ref: ....

(turn over)

Question 2

(a) You have completed wiring a new 230V domestic electrical installation that has a maximum demand of 60 amps.

Refer to the Electricity (Safety) Regulations and state:

(i) The Standard and Part of that Standard with which the wiring installed in the electrical installation must comply.

(1 mark)

____

____

Ref: ……………………………………

(ii) The name of the document you needed to have **before you commenced** wiring the electrical installation.

(1 mark)

____

Ref: ……………………………………

(iii) The name of the document you needed to provide to the owner of the new domestic electrical installation **after you have completed** wiring the electrical installation.

(1 mark)

____

Ref: ……………………………………

(iv) Which part of the new domestic electrical installation required inspection by a registered electrical inspector?

(1 mark)

____

Ref: ……………………………………

(turn over)

Question 2 continued

(v) Refer to the Electricity (Safety) Regulations and state the Standard and Section of that Standard that details the testing of the new installation.

(1 mark)

____

____

Ref: ……………………………………

(b) You have been requested by a network operator to **reconnect** a single-phase low voltage, MEN electrical installation on which prescribed electrical work has been carried out.

1. None of the prescribed electrical work required inspection.
2. **You had no involvement** in the prescribed electrical work.

Refer to the Electricity (Safety) Regulations and state **FIVE** actions you must carry out when doing this connection.

(5 marks)

(1) ____

____

(2) ____

____

(3) ____

____

(4) ____

____

(5) ____

____

Ref: ……………………………………

(turn over)

Question 3

AS/NZS 3000 states that a switchboard or switchboards shall be provided in an electrical installation for the mounting or the enclosure of switchgear and protective devices.

(a) An MEN electrical installation has only one switchboard.

State **TWO** of the main functions of that switchboard.

(2 marks)

(1) ____

____

(2) ____

____

(b) A main switchboard **can be** installed near an automatic fire-sprinkler.

Refer to AS/ZS 3000 and state **TWO** conditions that will permit a main switchboard to be installed near an automatic fire-sprinkler.

(2 marks)

(1) ____

____

(2) ____

____

Ref: ……………………………………

(turn over)

Question 3 continued

(c) A switchboard is constructed so the panel is hinged.

Refer to AS/NZS 3000 and state **TWO** requirements that **are specific to** the wiring and equipment on a hinged switchboard panel.

(2 marks)

(1) ____

____

(2) ____

____

Ref: ……………………………………

(d) Refer to AS/NZS 3000 and state:

(i) Whether a main switchboard in an electrical installation is required to have:

(A) A main earthing terminal or bar. State a reference to support your answer.

(1 mark)

____

Ref: ……………………………………

(B) An MEN connection (MEN link). State a reference to support your answer.

(1 mark)

____

Ref: ……………………………………

(turn over)

Question 3 continued

(ii) State **FOUR** conductors and equipment, other than functional earthing conductors, that must be connected to a main earthing terminal or bar.

(2 marks)

(1) ____

(2) ____

(3) ____

(4) ____

Ref: ....

(turn over)

Question 4

You are wiring a new three-phase, 400 V, factory and need to **determine the load of the highest loaded phase** of the installation so the correct size of the mains can be found.

Assume all motors, lighting, and loads in the socket outlets to have a unity power factor.

The loads are to be balanced across the three phases wherever possible.

Refer to AS/NZS 3000 and calculate the **load in amps** on each phase (red, white and blue) to determine the highest loaded phase of the installation.

Use the table on the following page for your calculations.

(10 marks)

Single-phase

Number	**Equipment**
12	38W Fluorescent lights
30	75W Fluorescent lights
18	10A socket outlets
9	15A Socket outlets
1	5kW water heater

Three-phase

Number	**Equipment**
2	9kW motors (15.8A per phase nameplate rating)
2	5kW chiller motors (7.25A per phase nameplate rating)

(turn over)

Question 4 continued

(a) Calculations

Load Group	**Calculation**	**Load on each phase (amps)**		
		R	**W**	**B**
Group				
Group				
Group				
Group				
				-
Total				

(b) Load on highest loaded phase =

Ref: ……………………………………

(turn over)

Question 5

You have completed wiring a new single-phase low voltage electrical installation that operates at standard low voltage. The installation includes submains to a garage and to an office.

(a) You have completed a visual inspection of the electrical installation.

Refer to AS/NZS 3000 and list the **sequence of tests** using test instruments that are recommended to be carried out on the electrical installation.

(4 marks)

Ref: ....

(turn over)

Question 5 continued

(b) State **TWO** reasons why the testing is carried out in the sequence listed in AS/NZS 3000.

(2 marks)

(1) ____

(2) ____

(c) Of the tests you have listed in (a) above:

(4 marks)

(i) Which test or tests **can only be carried out** with the electrical **installation live**?

(ii) Which test or tests **can be carried out** with the electrical installation **disconnected** from the electricity supply **or** the electrical installation **live**?

(iii) Which test or tests **can only be carried out** with the installation **disconnected** from the electricity supply?

(turn over)

Question 6

(a) You are to make additions and alterations to an existing 230V domestic electrical installation.

(i) Additional lights are to be installed in a hallway. These are to be supplied from an existing final subcircuit that is not RCD protected.

Refer to AS/NZS 3000 and state whether the additional lights require RCD protection. State a reference to support your answer.

(1 mark)

____

____

Ref: ……………………………………

(ii) A new final subcircuit from the switchboard will supply four socket outlets in a new bedroom. This final circuit is required to be RCD protected.

Refer to AS/NZS 3000 and state **where** in the final subcircuit the RCD protection is to be installed. State a reference to support your answer.

(1 mark)

____

____

Ref: ……………………………………

(iii) A new SRCD type socket outlet is to be installed in Zone 2 of a bathroom. The SRCD socket outlet will be supplied from **an existing final subcircuit** that is not RCD protected.

Refer to AS/NZS 3000 and state whether the **existing final subcircuit** supplying the SRCD socket outlet requires RCD protection. State a reference to support your answer.

(1 mark)

____

____

Ref: ……………………………………

(turn over)

Question 6 continued

(iv) Two additional socket outlets are to be installed in the lounge. These will be supplied from an **existing final subcircuit** that is not RCD protected.

Refer to AS/NZS 3000 and state whether the **existing final subcircuit** supplying the new lounge socket outlets requires RCD protection. State a reason to support your answer.

(1 mark)

Ref: ……………………………………

(v) A new final subcircuit from the switchboard is to be installed to supply a 32A socket outlet for a new free-standing electric range. This final subcircuit will not need to be RCD protected if two conditions are met.

Refer to AS/NZS 3000 and state those **TWO** conditions.

(2 marks)

(1)

(2)

Ref: ……………………………………

(turn over)

Question 6 continued

(b) You are installing:

- A new final subcircuit from an existing switchboard to a socket outlet in a primary school.
- A new final subcircuit from an existing switchboard to a socket outlet in a domestic residence.

(i) What type of RCD and residual current rating would you install in the **primary school**?

(1 mark)

Ref: ....

(ii) What type of RCD and residual current rating would you install in the **domestic residence**?

(1 mark)

(c) You have wired a new 230V domestic electrical installation. The installation comprises:

- Two lighting final subcircuits.
- Seven socket outlet final subcircuits.
- An electric range final subcircuit.
- An electric hot water cylinder final subcircuit.

(i) What is the minimum number of RCDs required on the switchboard to supply these final subcircuits?

(½ mark)

(turn over)

Question 6 continued

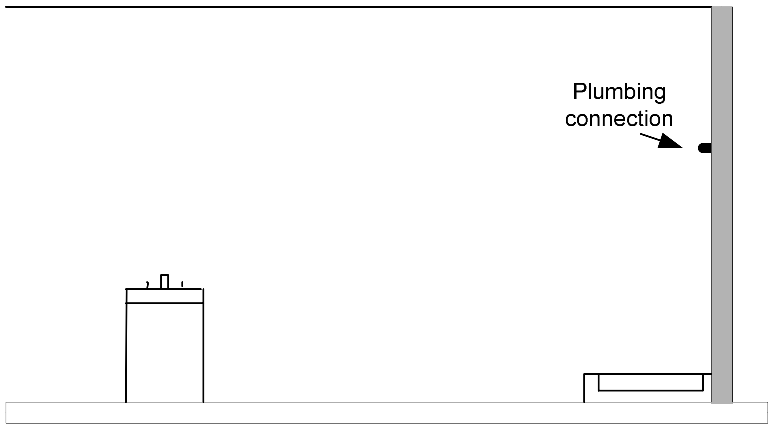
(ii) To which of the RCDs you have stated in (c)(i) above are the final subcircuits required to be connected

(1½ marks)

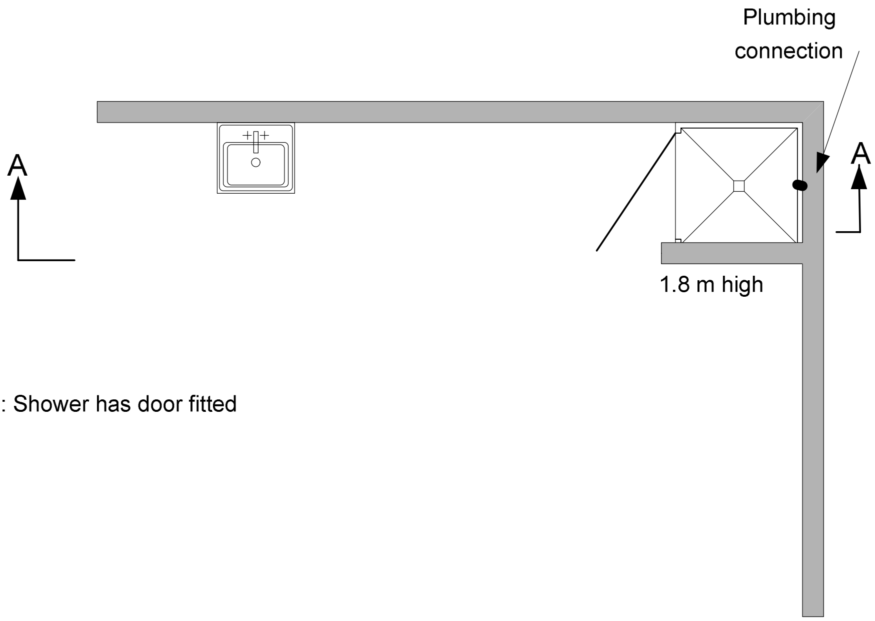
(turn over)

Question 7

The figure shows two views of a bathroom fitted with a shower and hand basin.



Sectional view A - A



Note: Shower has door fitted

Approx scale 1:50

(turn over)

Refer AS/NZS 3000 and answer the following.

(a) The shower

On **both** figures on the previous page, draw and label the zones for the shower. Include the dimensions in the labelling.

(3½ marks)

(b) The hand basin:
- Is of 20 litres capacity.
- Is fitted with a **flexible water outlet** (a flexible hose for hair washing).

On **both** figures on the previous page, draw and label the zones for the hand basin. Include the dimensions in the labelling.

(1½ marks)

(c) A single **230V** socket outlet is to be provided for a hair dryer adjacent to the hand basin. The socket outlet is not to be installed in a cupboard.

(i) Show the location for a socket outlet on **both** views.

(1 mark)

____

Ref: ....

(ii) State **TWO** methods of electrical protection for the socket outlet.

(2 marks)

(1) ____

____

(2) ____

____

Ref: ....

(turn over)

Question 7 continued

(d) In a **domestic bathroom**, zones are used to detail the IP ratings required for certain equipment or apparatus.

(i) What is the minimum IP rating for electrical equipment installed in Zone 0?

(½ mark)

Ref: ....

(ii) What is the minimum IP rating for electrical equipment installed in Zone 1?

(½ mark)

Ref: ....

(iii) What is the minimum IP rating for electrical equipment installed in Zone 2?

(½ mark)

Ref: ....

(iv) What is the minimum IP rating for electrical equipment installed in Zone 3?

(½ mark)

Ref: ....

(turn over)

Question 8

AS/NZS 3000 details the safety outcomes required for an electrical installation, so that installation is "electrically safe" under the Electricity Regulations.

(a) Refer to AS/NZS 3000 and state **FOUR** methods of protection that can be used to provide protection against **fault protection (indirect contact)** in an electrical installation.

(2 marks)

(1) ______________________________

(2) ______________________________

(3) ______________________________

(4) ______________________________

Ref: ……………………………………

(turn over)

Question 8 continued

(b) For **TWO** of the methods of protection you have stated in (a) above, briefly state how the method achieves the safety outcome required.

(4 marks)

(1) ______________________________

(2) ______________________________

(c) For each of the two methods of protection you have stated in (b) above, briefly state how you would verify that the method is operating correctly to provide the required protection.

(4 marks)

(1) ______________________________

(2) ______________________________

(turn over)

Question 9

You have been asked to install a 4-core neutral screened **copper** cable from a three-phase 400V, three-phase distribution panel to a three-phase, 400V service centre building in a ski-field.

You need to find, by calculation the **minimum** size 4-core neutral screened **copper** cable that will meet the load and voltage drop requirements.

(a) Use the following information and the information in the tables on pages 27, 28 and 29 and calculate the **minimum size cable that will meet the loading requirements**.

- The cable route length is 15.7 m.
- The service centre building load is 63 kW.
- The cable will be buried direct.
- The ambient soil temperature is 15 ^{0}C.
- The voltage drop between distribution panel and the service centre switchboard must not exceed 2.5%.
- The conductor temperature is assumed to be 75 ^{0}C

(5 marks)

(turn over)

Question 9 continued

(b) Use the following information and the information in the tables on pages 27, 28 and 29 and calculate the **minimum size cable that will meet the voltage drop requirements.**

- The cable route length is 15.7 m.
- The service centre building load is 63 kW.
- The cable will be buried direct.
- The ambient soil temperature is 15 ^{0}C.
- The voltage drop between distribution panel and the service centre switchboard must not exceed 2.5%.
- The conductor temperature is assumed to be 75 ^{0}C

(4 marks)

(c) State the minimum size 4-core neutral screened copper cable that will meet the load and voltage drop requirements.

(1 mark)

(turn over)

Question 9 continued

The following are extracts from AS/NZS 3008.1.2.

Table 9

Current Carrying Capacities of Two-Core O.6/1 kV Insulated and Sheathed (including Neutral Screened) Cables with or without Earth Conductor, Armoured or Non-Armoured Cables

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Conductor size	**Current carrying capacity A**															
	Unenclosed				**Enclosed**								**Buried Direct**		**Underground non-metallic wiring enclosure**	
	Spaced		**Touching**		**Non-metallic wiring enclosures in air – round cable**		**Non-metallic wiring enclosures in air – flat cable**		**In non-metallic wiring enclosures or unenclosed partially surrounded by thermal insulation**		**Completely surrounded by thermal insulation**					
mm^2	**Cu**	**Al**	**Cu**	**Al**	**Cu**	**Al**	**Cu**	**Al**	**Cu**	**Al**	**Cu**	**Al**	**Cu**	**Al**	**Cu**	**Al**
1	17	--	16	--	13	10	15	11	11	9	8	-	24	-	19	-
1.5	22	-	21	-	16	13	19	15	15	11	10	-	31	-	24	-
2.5	31	-	30	-	23	17	25	19	21	16	15	-	44	-	34	-
4	42	-	39	-	30	23	33	25	27	22	19	-	57	-	44	-
6	52	-	50	-	39	30	42	32	35	27	25	-	72	-	56	-
10	73	-	68	-	54	41	57	43	49	38	34	-	96	-	75	-
16	97	75	91	71	72	55	75	57	65	50	46	35	127	97	97	75
25	131	100	120	95	100	76	101	76	90	71	60	47	160	127	127	98
35	160	125	148	114	120	89	120	89	105	82	74	58	198	154	154	121

Note: The ratings are based on 30^0C ambient air temperature and 15^0C ambient soil temperature

(turn over)

Question 9 continued

Table 12

Current Carrying Capacities of Three-Core And Four-Core O.6/1 kV Insulated and Sheathed (including Neutral Screened) Cables with or without Earth Conductor, Armoured or Non-Armoured Cables

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Conductor size	**Current carrying capacity A**															
	Unenclosed				**Enclosed**								**Buried Direct**		**Underground non-metallic wiring enclosure**	
	Spaced		**Touching**		**Non-metallic wiring enclosures in air – round cable**		**Non-metallic wiring enclosures in air – flat cable**		**In non-metallic wiring enclosures or unenclosed partially surrounded by thermal insulation**		**Completely surrounded by thermal insulation**					
mm^2	**Cu**	**Al**	**Cu**	**Al**	**Cu**	**Al**	**Cu**	**Al**	**Cu**	**Al**	**Cu**	**Al**	**Cu**	**Al**	**Cu**	**Al**
1	15	--	14	--	11	9	14	10	11	8	7	-	21	-	17	-
1.5	18	-	17	-	15	11	17	13	14	11	9	-	26	-	21	-
2.5	26	-	25	-	21	16	23	17	19	15	13	-	37	-	29	-
4	35	-	33	-	27	21	30	23	25	19	17	-	48	-	37	-
6	46	-	42	-	35	27	39	30	33	25	22	-	61	-	47	-
10	52	-	58	-	48	38	52	40	44	34	29	-	81	-	63	-
16	82	64	78	60	64	49	68	52	59	46	39	30	106	83	81	64
25	111	86	104	81	90	68	95	72	82	64	52	40	138	107	106	83
35	137	106	125	99	105	80	105	80	96	74	64	49	165	127	127	100

Note: The ratings are based on 30^{0}C ambient air temperature and 15^{0}C ambient soil temperature

Table 27(1)

Rating Factors for Variations in Ambient Temperature for Cables in Air or Heated Concrete Slabs and for Cables Buried Direct in the Ground or in Underground Wiring Enclosures – Air And Concrete Slab Temperatures

1	2	3	4	5	6	7	8	9	10	11
Conductor temperature ^{0}C	**Rating Factor Ambient temperature**									
	15	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
150	1.07	1.05	1.03	1.00	0.98	0.96	0.94	0.91	0.89	0.87
110	1.08	1.06	1.03	1.00	0.97	0.93	0.90	0.87	0.83	0.79
90	1.15	1.09	1.05	1.00	0.95	0.91	0.85	0.80	0.74	0.66
80	1.17	1.12	1.06	1.00	0.95	0.89	0.82	0.75	0.68	0.59
75	1.18	1.12	1.06	1.00	0.94	0.88	0.80	0.72	0.63	0.53

(turn over)

Question 9 continued

Table 27(2)

Rating Factors for Variations in Ambient Temperature for Cables in Air or Heated Concrete Slabs and for Cables Buried Direct in the Ground or in Underground Wiring Enclosures – Soil Temperatures

1	2	3	4	5	6	7	8
Conductor temperature ^{0}C	**Rating Factor**						
	Ambient temperature						
	10	**15**	**20**	**25**	**30**	**35**	**40**
110	1.02	1.00	0.97	0.94	0.92	0.89	0.86
90	1.04	1.00	0.96	0.93	0.91	0.87	0.83
80	1.04	1.00	0.95	0.92	0.88	0.83	0.78
75	1.04	1.00	0.95	0.91	0.86	0.81	0.75

Table 42

Three-Phase Voltage Drop at 50Hz of Multicore Cables with Circular Copper Conductors

Conductor size mm^2	**Three-phase voltage drop at 50 Hz, mV/A.m**									
	Conductor temperature, ^{0}C									
	45		**60**		**75**		**90**		**110**	
	Max.	**0.8 p.f.**	**Max.**	**0.8 p.f.**	**Max.**	**0.8 p.f.**	**Max.**	**0.8 p.f.**	**Max.**	**0.8 p.f.**
1	40.3	-	42.5	-	44.7	-	46.8	-	49.7	-
1.5	25.9	-	27.3	-	28.6	-	30.0	-	31.9	-
2.5	14.1	-	14.9	-	15.6	-	16.4	-	17.4	-
4	8.77	-	9.24	-	9.71	-	10.2	-	10.8	-
6	5.86	-	6.18	-	6.49	-	6.80	-	7.22	-
10	3.49	-	3.67	-	3.86	-	4.05	-	4.29	-
16	2.19	-	2.31	-	2.43	-	2.55	-	2.70	-
25	1.39	-	1.47	-	1.54	-	1.61	-	1.71	-
35	1.01	-	1.06	-	1.11	-	1.17	-	1.24	-

Note: To convert to single-phase values multiply the three-phase value by 1.155

For Candidate's Use

In the box, write the number of **EXTRA** sheets you have used. Write **NIL** if you have not used any

For Examiner's Use Only

Questions Answered	**Marks**	
1		
2		
3		
4		
5		
6		
7		
8		
9		
TOTAL		